UNDERSTANDING NATURAL VARIATIONS OF DISSOLVED METHANE IN AREAS OF ACCELERATING MARCELLUS SHALE GAS DEVELOPMENT

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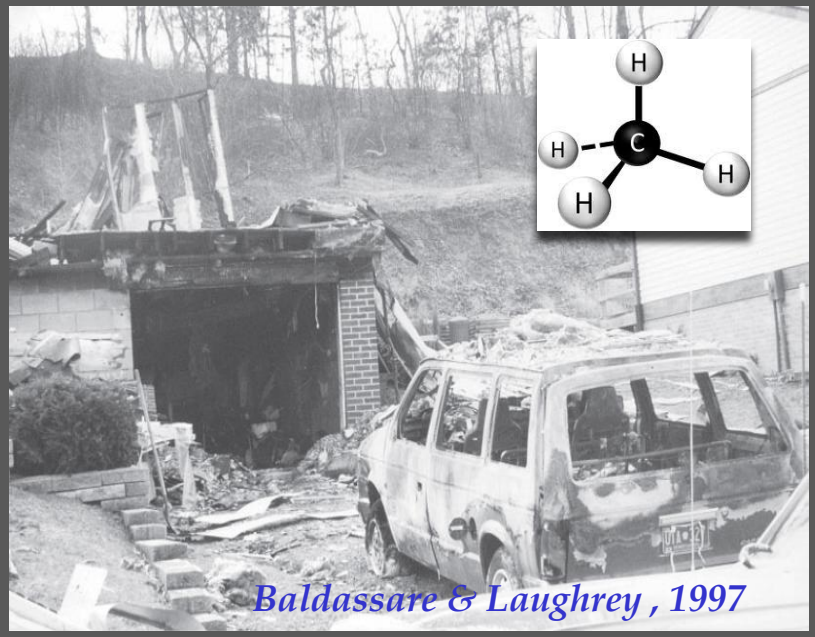
DISSOLVED METAHNE OR "STRAY GAS"

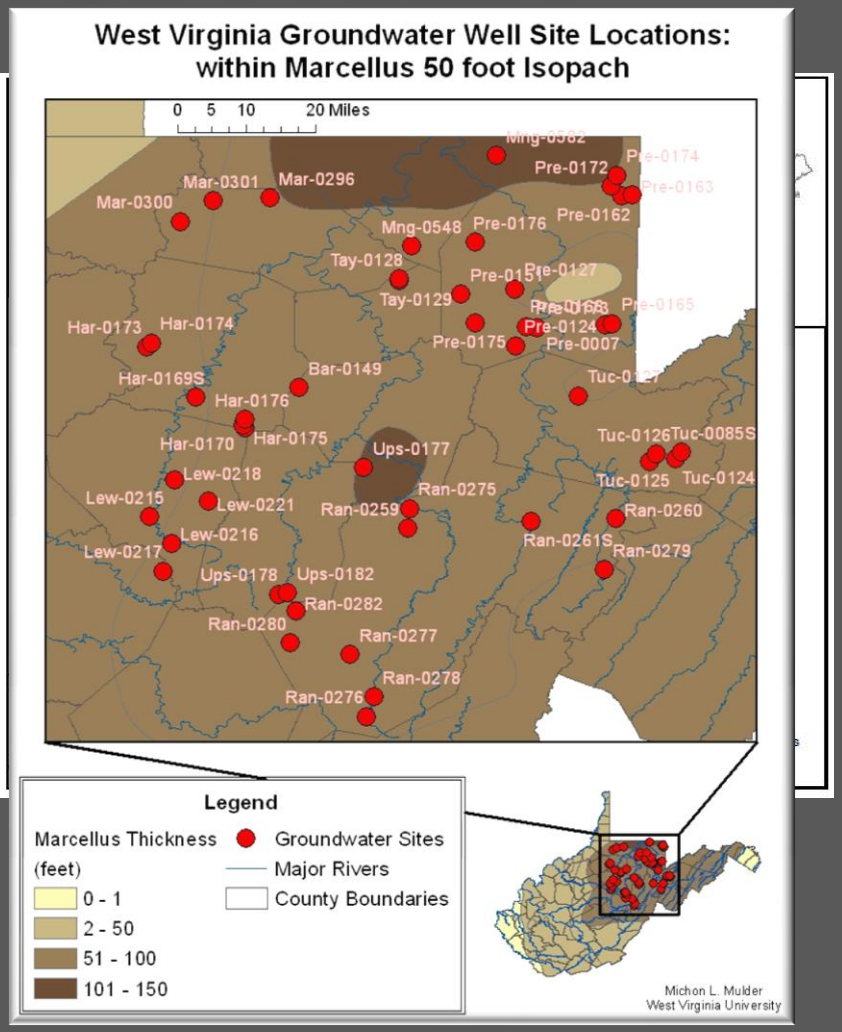
- Colorless & Odorless
- Flammable
- Explosive range: 5-15%
- Solubility in water : 26-32 mg/l



Problems:

Fires; Explosions; Asphyxiation; Groundwater Contamination

STUDY AREA



SAMPLED GW AQUIFERS
Dunkard Gp.
Monongahela Gp.
Conemaugh Gp.
Allegheny Fm.
Pottsville Gp.
Greenbrier Gp.
Pocono Gp.
Hampshire Fm.
Chemung Gp.

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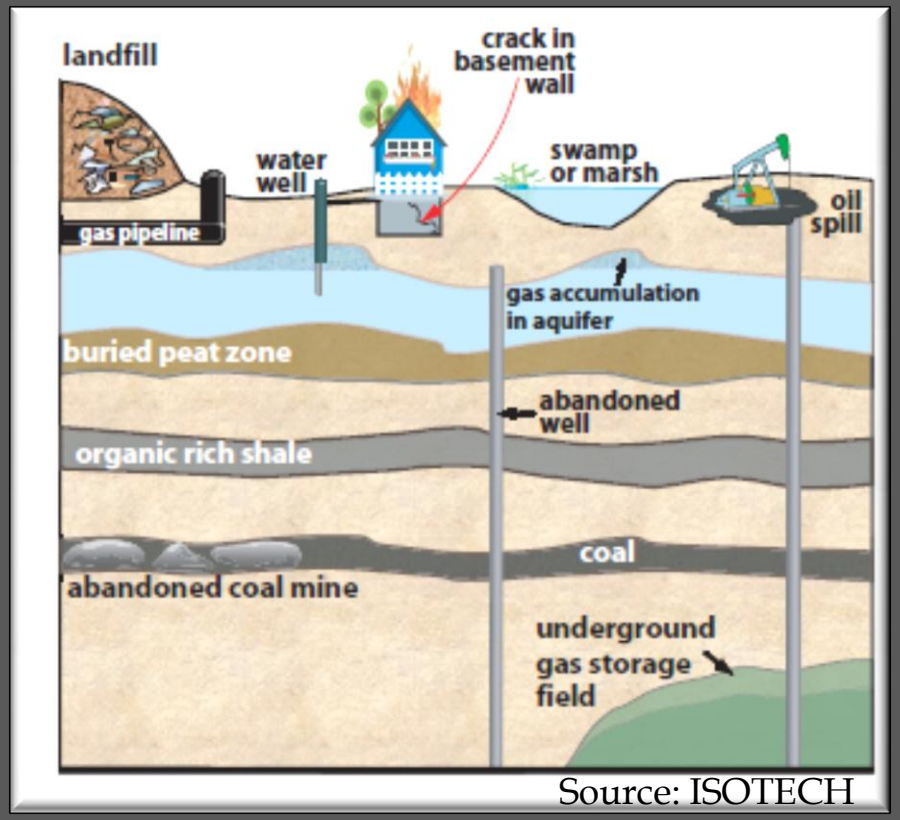
Sources of Stray Methane

- Landfills, Swamps and Marshes
- Microbial gas in shallow aquifers
- Abandoned & operating coal Mines
- Gas storage fields
- Gas pipelines
- Abandoned & operating gas wells



Pathways of Methane Formation

BIOGENIC

Bacterial gas

THERMOGENIC

Coal bed & Natural gas

ABIOGENIC

Crustal & mantle gas

ACETATE FERMENTATION

$CH_3COOH \rightarrow CH_4 + CO_2$

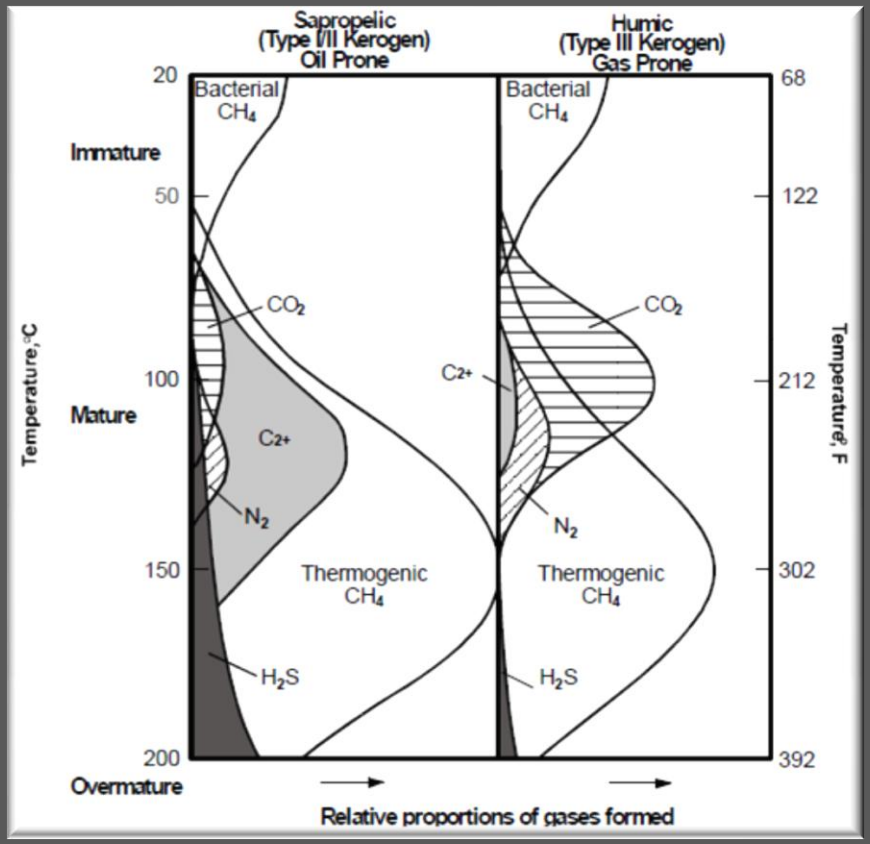
Near surface environment- Landfill, Marsh etc.

CO_2 REDUCTION

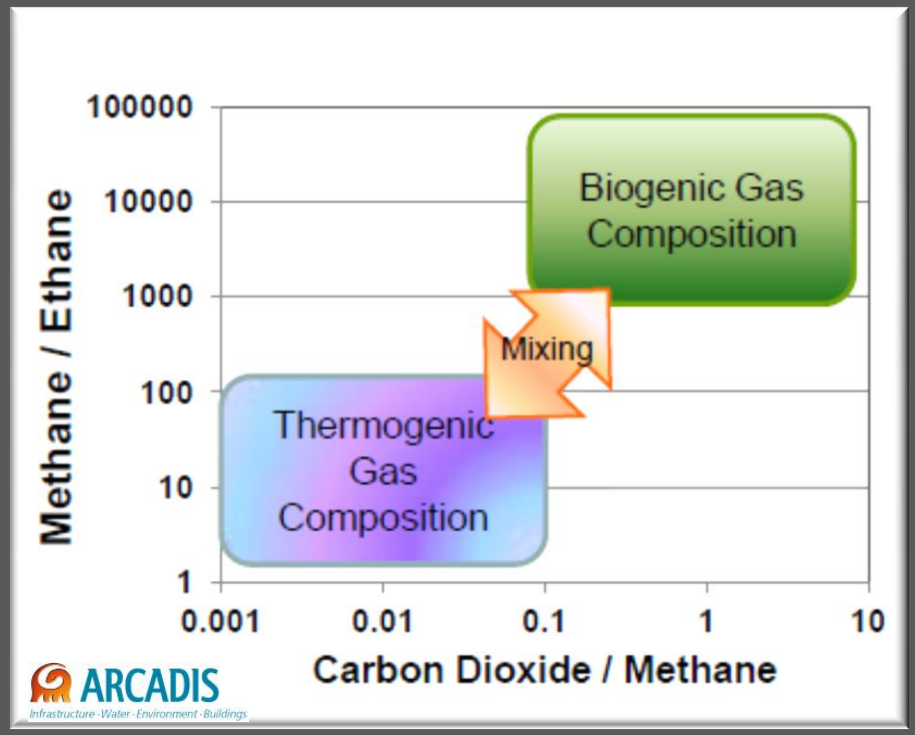
$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$

Drift gas from deeper formations

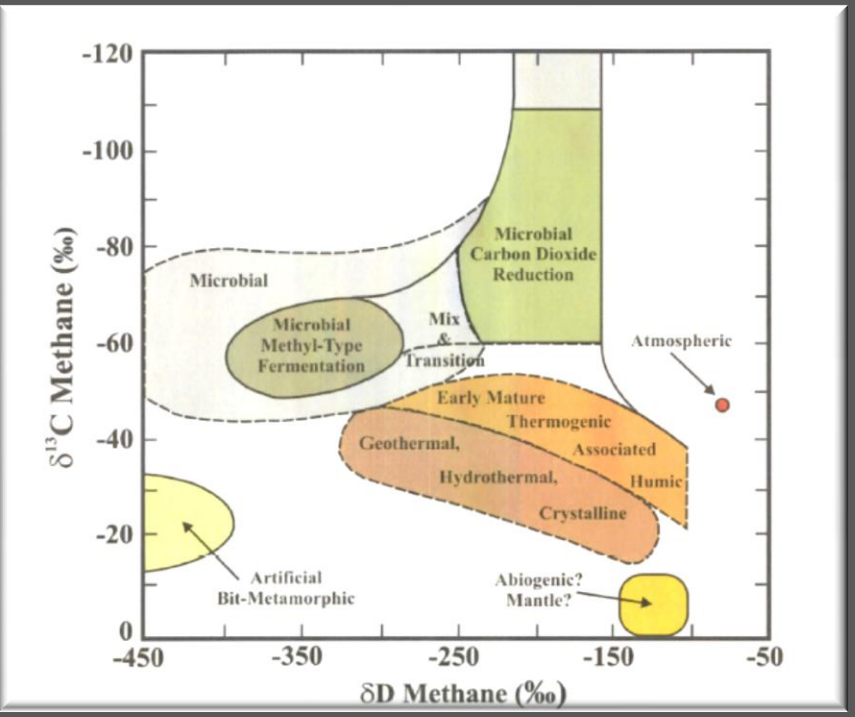
Using gas composition to identify methane origin

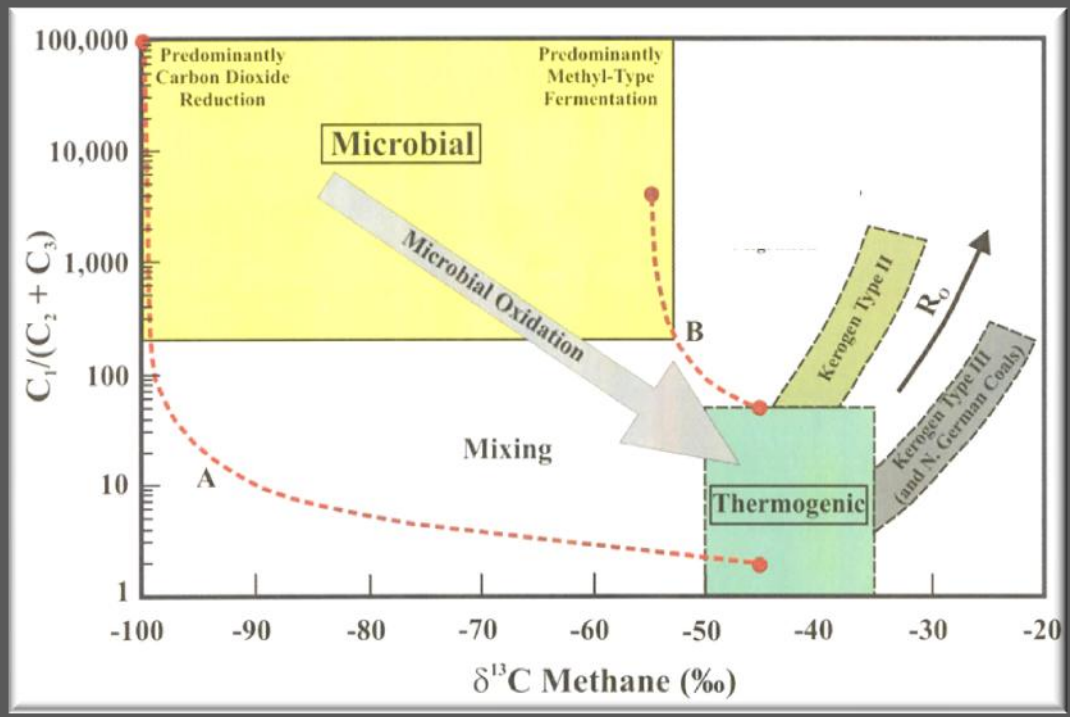


(Hunt , 1996)



Using stable isotopes to identify methane origin





$\delta^{13}C\ (‰) = (^{13}C/^{12}C_{sample} / {}^{13}C/^{12}C_{standard} - 1) \cdot 1000$ $\delta D\ (‰) = (^{2}H/^{1}H_{sample} / (^{2}H/^{1}H_{standard} - 1) \cdot 1000$

Modified Graphs from Neiman 2002

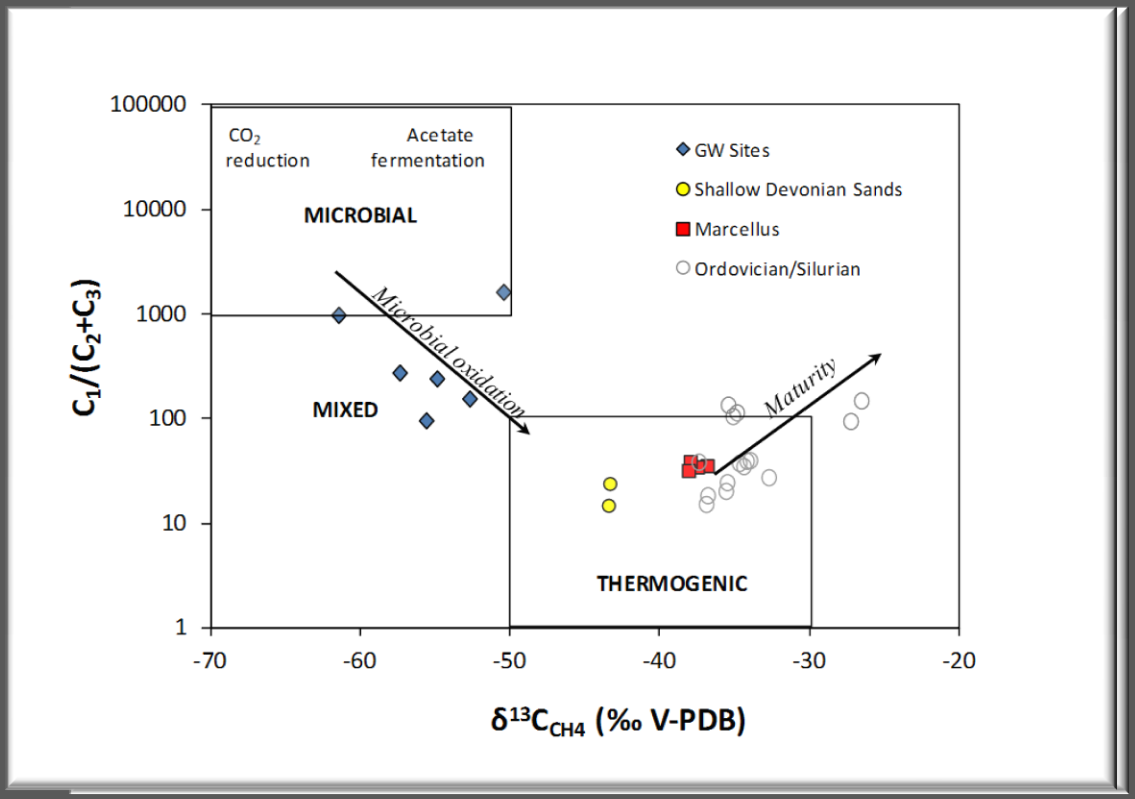
Understanding Sources of Methane

GW methane data :

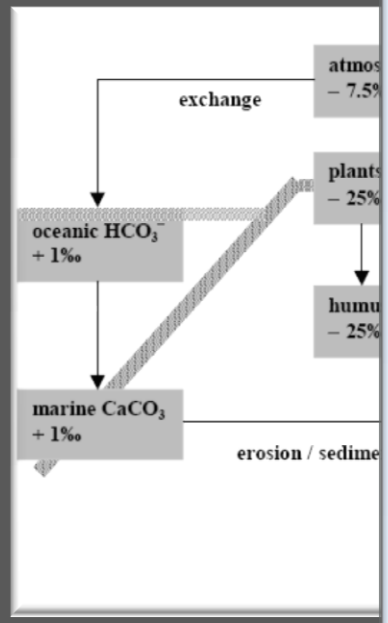
- MS thesis of M. Mulder

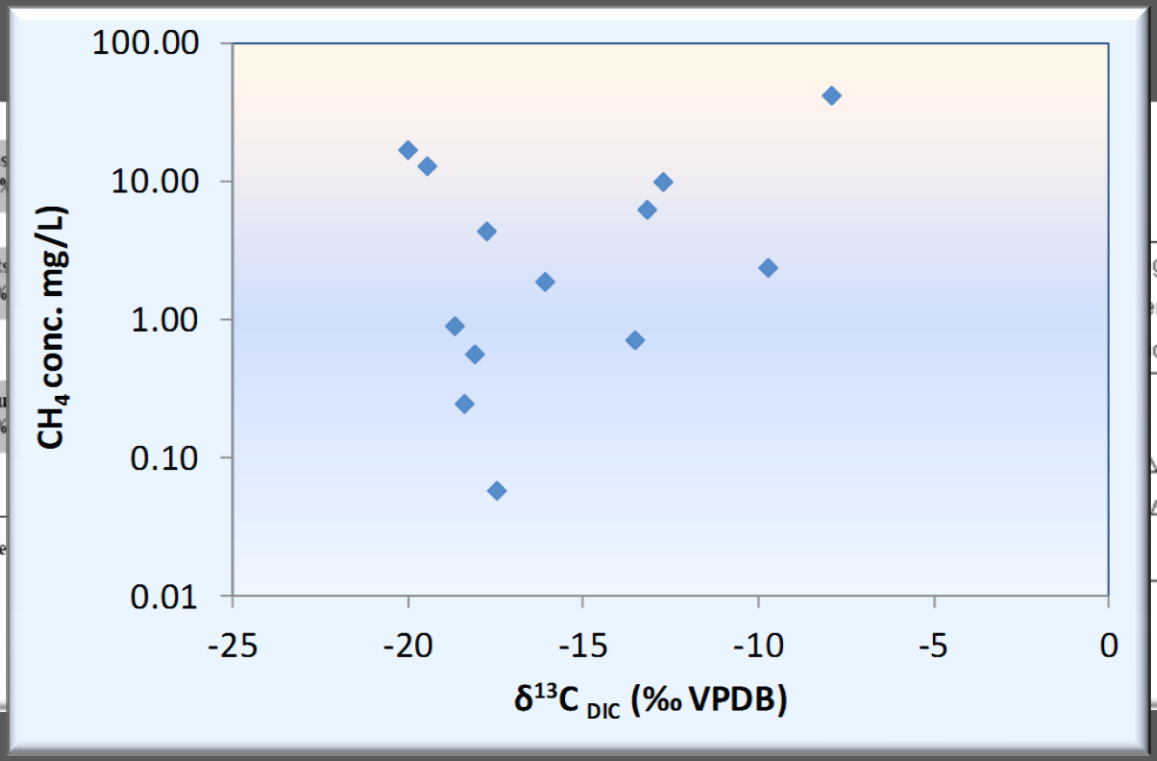
Methane data :

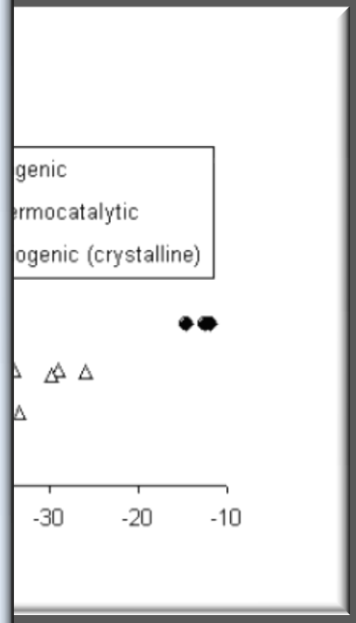
- Marcellus & Shallow Devonian Sands (samples collected)
- Ordovician & Silurian gases (published literature)



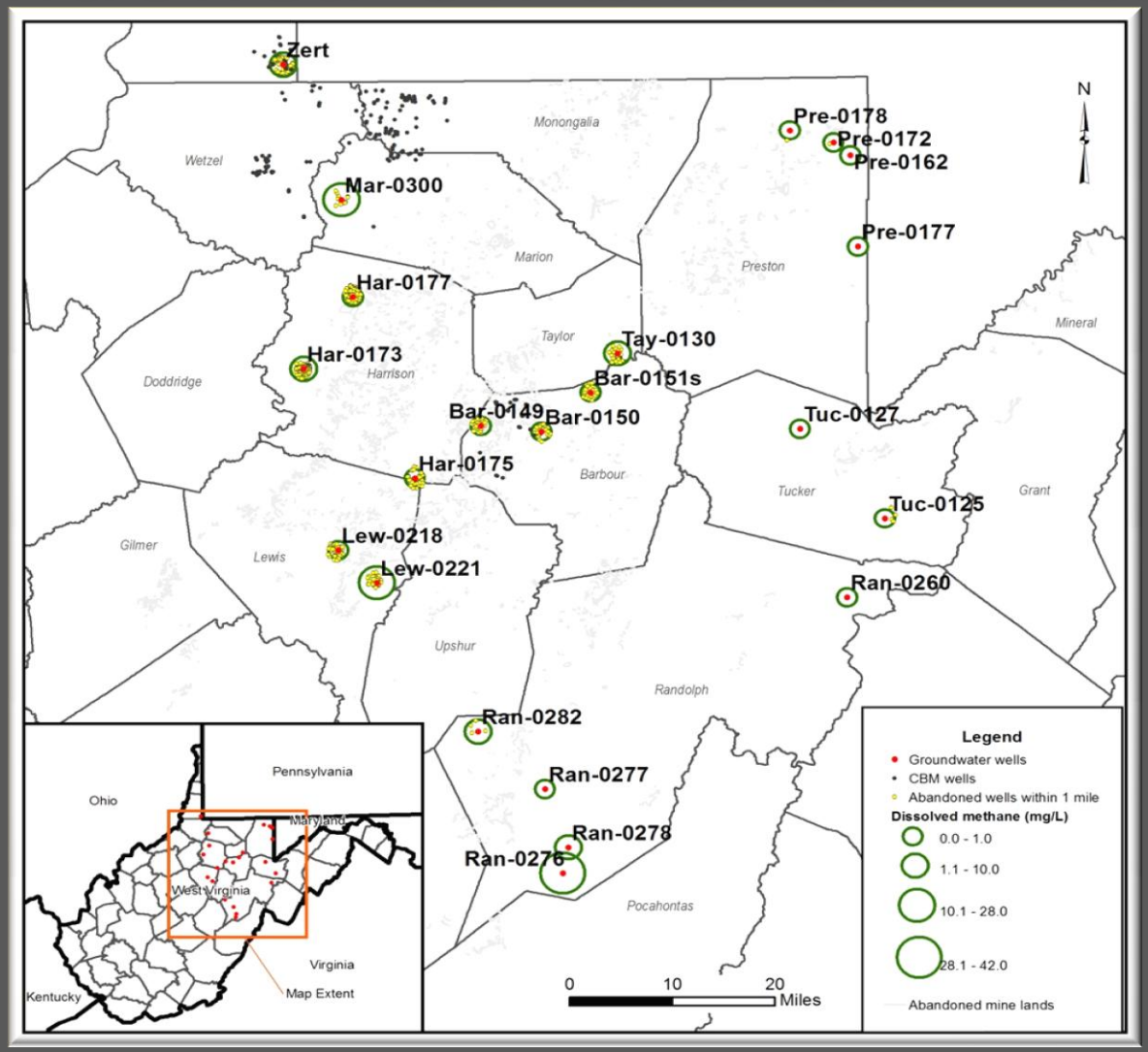
Other evidences of methane origin: $\delta^{13}C_{DIC}$



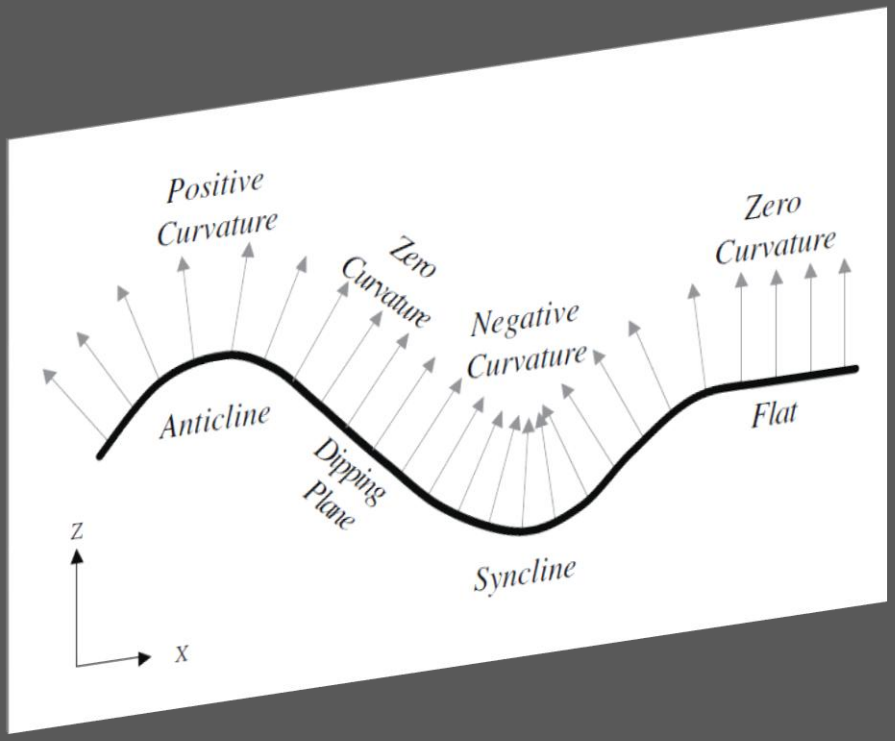


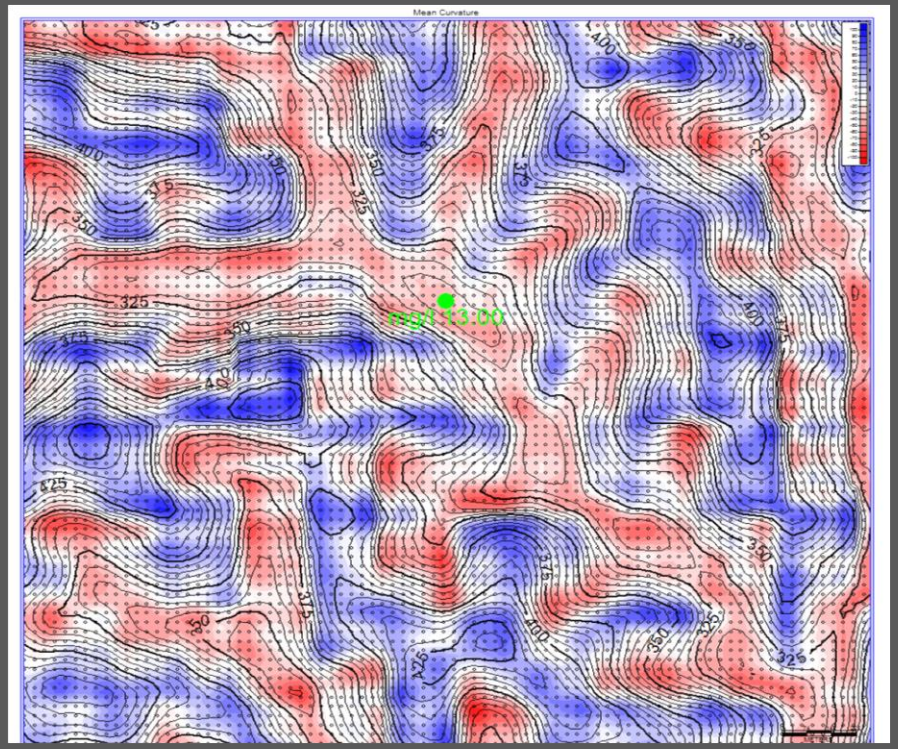


Relation to Mining and Abandoned Oil and Gas Activity



Relation to Topographic Curvature





Conclusions

Stable isotopic signatures and gas geochemistry can be used to

- Identify possible sources of methane in groundwater aquifers and surface waters
- Identify changes in hydrological connections

Essential criterion to be met:

- Good understanding of baseline and temporal variations in gas concentrations and isotopic signatures
- Well established dissolved gas sampling protocols

Ongoing Work…

- End-member characterization of natural gas in formations overlying Marcellus, active/in-active coal mines, microbial gas in shallow subsurface in southern Pennsylvania and north central West Virginia
- Assess effect of sampling methodologies on isotopic and molecular compositions of dissolved gases sampled using different techniques
- Test applicability of stable isotopes and gas composition to identify changes in hydrologic connections related to hydraulic fracturing.

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